Must a Four-dimensionalist believe in Temporal Parts?*

I. Introduction

The following quotation, from Frank Jackson, is the beginning of a typical exposition of the debate between those metaphysicians who believe in temporal parts, and those who do not:

> The dispute between three-dimensionalism and four-dimensionalism, or more precisely, that part of the dispute we will be concerned with, concerns what persistence, and correllatively, what change, comes to. Three-dimensionalism holds that an object exists at a time by being *wholly present* at that time, and, accordingly, that it persists if it is wholly present at more than one time. For short, it persists by *enduring*. Four-dimensionalism holds that an object exists at a time by having a *temporal part* at that time, and it persists if it has distinct temporal parts at more than one time. For short, it persists by *perduring* (Jackson 1998, p. 138).

In the light of these comments, some readers will perhaps find the question that forms the title of this paper a little puzzling. They may have learned to use the terms 'four-dimensionalism' 'perdurantism' and 'belief in temporal parts' interchangeably; or perhaps even to define one in terms of the other.

Such a usage, however, is inapposite. We might imagine a Flatland-like world of two spatial dimensions and one temporal, whose philosophers are divided between a theory of persistence on which they persist by having temporal parts, and a theory on which they persist by being wholly located in each of several times. This is just the same issue we face, but at least the label 'four-dimensionalism' seems inapposite: the four-dimensionalist Flatlanders believe in only three dimensions![1]

In any case, this is not the usage intended by Jackson. Temporal parts are a 'part of the dispute' between four- and three-dimensionalists, not the whole of that dispute. For Jackson, four-dimensionalism is a broader programme that (allegedly) entails a certain specific theory of persistence, namely perdurantism. That is the usage of 'four-dimensionalism' that I have in mind, and my question is whether the alleged entailment actually holds.

First, I'll set up definitions of 'four-dimensionalism' and 'endurantism' that are as strong as possible without actually making them analytically incompatible. Second, I consider an argument for temporal parts which falls rather naturally out of the definition of 'four-dimensionalism', and reject it as unconvincing. Third, I consider the argument that is most usually given against endurantism, and for temporal parts, the Problem of Change. I offer a new endurantist solution to this problem. With neither argument seeming to offer an apriori connection between four-dimensionalism and temporal parts, I conclude that there is no such connection.

II. Endurantism

Things are often located at more than one time. Take me, for example: I'm somewhere at this very minute (call that t_1). And I was somewhere five minutes ago (t_0). I might have moved in the intervening time, but you'll find me at both times: both now and five minutes ago. Following the now standard terminology, (Johnston 1987) I'll use the word 'persistence' to cover multiple location in time in this neutral sense.

But people often want to give theories of persistence: and the theories they give fall into two groups: those that believe in persistence with temporal parts, or perdurance, on the one hand, and those that believe in persistence without temporal parts, or endurance, on the other. According to the temporal parts view, the thing that persists through time (me, say) is the sum or composite of the several distinct things each of which occupy just a single one of the times I am located at. These things, my temporal parts, or time-slices, are located at just one of the times at which I'm located (while I am located at many). So, on this view, while I'm multiply located at t_1 and t_0, that's so in virtue of there being some other things, singly located at each of t_1 and t_0, which are my parts.

On the endurantist view, however, this is not the case. According to endurantism, I'm wholly located at both t_1 and t_0, without having a part located at t_1 and not t_0, or a part located at t_0 and not t_1. It's important not to confuse 'wholly located' (which is the opposite of 'partially located') with 'singly located' (which is the opposite of 'multiply located'). Everyone can agree that some things are multiply located in time, that some things persist, in other words. Everyone can agree, too,that some things (be they persisting things, or only the temporal parts of persisting things) are wholly located at certain times. The difference between endurantism and perdurantism is on the issue of whether some things are *both* wholly and multiply located at those times at which they exist. An endurantist says yes, there are, a perdurantist says no.

Sometimes endurantists claim that it's just a big mistake to even speak of temporal parts — that perdurance is not only a false metaphysical view, but an incoherent one. According to P. T. Geach, for example, while speaking of temporal parts is 'very natural',

it 'involves an erroneous analysis of propositions into subject and predicate' (Geach 1968, p. 182). For the purposes of this paper, I'm just going to set aside this line of thought. The reason is that, if correct, it calls four-dimensionalism into question along with perdurantism — this kind of endurantist thinks of time as different from space in such a profound way that they cannot be a four-dimensionalist (and the kind of endurantism I want to defend is a kind compatible with four-dimensionalism).

III. Four-dimensionalism

The core of four-dimensionalism, as I understand it, is the Dimensionality Thesis: that the universe is a four-dimensional manifold of which one of the dimensions is time. This doctrine on its own, however, is insufficiently strong to be of much help to us. It's certainly much weaker than what most writers mean by the term 'four-dimensionalism'. So far as I am aware, the closest anyone has come to defending the Dimensionality Thesis on its own, is D. C. Williams on 'the theory of the manifold':

> The theory of the manifold leaves abundant room for the sensitive observer to record any describable difference he may find, in intrinsic quality, relational texture, or absolute direction, between the temporal dimension and the spatial ones (Williams 1966, p. 301).

Even Williams, though, goes on the argue that it is unnecessary to add any of the further 'differences' between space and time that he describes here. This is typical — besides affirming the Dimensionality Thesis, four-dimensionalists also claim that time is like space in various different ways.

This second part of four-dimensionalism is responsible for much of its philosophical appeal, as it enables us to solve puzzles and construct arguments about time by appealing to the analogous spatial cases.[2] I will subsume the varying different ways in which four-dimensionalists allege time to be like space under a single vague doctrine, the Analogy Thesis that time is somehow, strongly or weakly, analogous to space.

Four-dimensionalism, then, on my account, is the conjunction of the Dimensionality Thesis with the Analogy Thesis. We must bear in mind, however, that the Analogy Thesis is vague, and can be held in stronger and weaker forms. Accordingly, there will be stronger and weaker versions of four-dimensionalism. I'm going to argue that even the stronger versions of four-dimensionalism are still compatible with endurantism.

IV. The Argument from Analogy

A version of the Analogy Thesis, in the shape of an analogy between extension in space and persistence through time, is often used to introduce the concept of a temporal part. Here is one example from a recent defence of perdurance by Theodore Sider:

> Persistence through time is much like extension through space. A road has spatial parts in the subregions of the region of space it occupies; likewise, an object that exists in time has temporal parts in the various subregions of the total region it occupies (Sider 1997, p. 197).

And another from Richard Taylor's classic collection of analogies between space and time:

> [T]he concept of length or extension has a place in both [spatial and temporal] contexts, though this is easily overlooked. Things can be spatially long or short, but so too they can have a long or brief duration, i. e., be temporally long or short.... The notion of length in turn leads to that of *parts*, both spatial and temporal (Taylor 1964, p. 382).

Though these passages may not have been intended as arguments by their authors, they certainly suggest an argument from the Analogy Thesis to the view that things persist by perduring, by having temporal parts. This is the Argument from Analogy:

A1 Time is analogous to space; in particular, persistence is analogous to extension.

A2 All things extend by having different parts at different places.

A3 All things persist through time by having different parts at different times.

Premise A1 here is just a version of the Analogy Thesis. Premise A2 is the observation that macroscopic objects typically do have spatial parts: I fill this bit of space to my left by having my left arm there, and this distinct bit of space, to my right, by having a distinct part, my right arm, there. Each arm extends through its region of space by having many distinct cells as parts, each filling a distinct, smaller region of space, and so on down to the subatomic level.

One thing you might do with this argument, if you wanted to deny the conclusion, is to take it as a modus tollens against premise A1. If you thought that endurantism was more obviously true than the Analogy Thesis, you might reject or weaken the Analogy Thesis. Such a view might even remain recognisably four-dimensionalist. After all, the

Analogy Thesis only asserts some, stronger or weaker, analogy between time and space. A weaker form of the Analogy Thesis could assert that time is just like space, *except* that objects fill time by enduring, while they fill space by having spatial parts. This would still be strong enough to do some work, still allowing arguments from the Analogy Thesis against the passage of time, for example. D. H. Mellor accepts just such a weak version of four-dimensionalism, and argues that it is compatible with special relativity (indeed more compatible than a version including a stronger Analogy Thesis) (Mellor 1998, pp. 53–56).

This line of argument is unsatisfying for our purposes, as it tends to trivialise our question. Make four-dimensionalism weak enough, and of course it can be compatible with anything you like. So I would like a defence to the Argument from Analogy that allows the Analogy Thesis, and thence four-dimensionalism, to be held in as strong a form as possible.

Suppose that the Analogy Thesis is to be affirmed in a strong enough form to make an analogy between spatial extension and temporal persistence. Now the argument can be treated as a modus tollens against premise A2. Just as there is a debate to be had between endurantists and perdurantists about how things persist through time, there should be an analogous debate to be had about how things extend through space. Analogous to perdurance, we have pertension, filling space by having distinct parts in distinct places; analogous to endurance, we have entension, filling space by being wholly located in each of several places. The defence against the argument from analogy is that just as things might endure through time, they might (and perhaps do) entend through space.[3]

In fact there may be good reasons for thinking that some (if not all) things do entend, especially those things that have no parts — that are 'mereologically simple':[4] the Argument from Avogadro:

V1 All mereological simples are extensionless.

V2 There are only finitely many simples.

V3 All objects are mereological sums of simples.

V4 All objects are sums of finitely many extensionless things. (from V1,V2, and V3)

V5 All sums of only finitely many extensionless things are extensionless.

V6 All objects are extensionless. (from V4 and V5)

V6 is absurd — if it was true, we wouldn't have a problem about whether things entend or pertend! I take this argument as a reductio against V1. It only remains to draw the contradiction explicitly:

V7 But of course some objects are extended!

V8 Some simples have extension; they entend. (reductio against V1)

The most important premise in this argument is V2. I take it that V2 is a discovery of physical science — the discovery of Avogadro's number, the number of hydrogen atoms in a gram of hydrogen. Armed with Avogadro's number, and a theory of the subatomic constitution of matter, we can arrive at a finite total number of the simple objects that make up any ordinary finitely massive material object, like a chair or a table, (or the universe, for that matter).

Substantivalists might object to V2 on the grounds that it counts only the material objects, and not the continuum many point-instants of space-time. For the purposes of this paper, I wish to be neutral on the issue of substantivalism: I am only interested in the manner in which material objects like chairs and tables extend (or persist) and not in the manner in which regions of space-time do so. Plausibly, space-time, if it exists, extends by pertending, and persists by perduring — but that's not the issue here. The argument from Avogadro is intended to be restricted to material objects and material simples, and substantivalist objectors are welcome to substitute throughout 'material simple' for 'simple' and 'material object' for 'object' throughout.

So what are these entending simples? I think that it is most likely that they are the most fundamental objects of physics, leptons and quarks. Current physics regards these objects as mereologically simple (unlike nucleons, such as protons, which are made of quarks), and is silent on whether they are extended — they are, at largest, too small to be practically measurable.[5]

An important thing to note about my argument that quarks and leptons entend is that it has many empirical premises. V2 is an empirical premise; so is the mereological simplicity of quarks and leptons (it may yet be discovered that they have smaller parts in turn); so too are those things that are known about the extension, if any, of these objects. It follows that whether that some things entend (as I have argued), or whether, on the contrary, everything pertends (in which case V2 will turn out to be false) is an empirical matter. And, if we accept the Analogy Thesis in its strongest form, we should think that the issue of whether anything endures is likewise an empirical matter.

It may be objected here that science is not in the business of discovering which things are mereologically simple. Instead, science discovers which things are, in practice, indivisible. In moving from the in-practice indivisibility of fundamental objects to the view that they are mereologically simple, we cross the boundary from science to metaphysics.

There is a logical gap, to be sure, between on the one hand, the data that we have empirically available to us, about which things are divisible into their proper parts in a laboratory, and on the other, the theories we concoct about which things have proper parts

to be divided. But that is no big news: the underdetermination of theory by evidence is ubiquitous in science. If that alone means that science can say nothing about whether an object has parts, then science can say very little.

Moreover, the idea that the nature and number of parts an object has is an empirical matter is quite in line with orthodox mereology. It's a striking feature of classical mereology that it leaves open all questions of whether there are simples, and if so, the nature and number of those simples. Those are questions that involve 'a geometric or at least a topological component, which introduces considerations essentially external or mereology' (Simons 1987, p. 43). It's not to difficult to imagine that such considerations might be, finally, empirical in nature.

The final objection to entention may be that it is absurd, inconceivable, or impossible that something should extend without having parts. One answer to that is that it is conceivable because it is conceived, at least by me, and, indeed, by some other metaphysicians. According to Peter van Inwagen (van Inwagen 1990b, p. 98), Aristotle held that living organisms entend. Hermann Weyl took seriously enough the proposal that some regions of space entend to construct an argument against it: the Tile Argument (Salmon 1975, pp. 65–66), which shows that the Pythagorean Theorem doesn't hold in such spaces. This of course does not affect my proposal, which is that some material objects, not regions of space, entend. In any case, if it were demonstrably true that entention is absurd, the Argument from Analogy would be redundant. Given the Analogy Thesis, for any demonstration of the incoherence of entention, there should be an analogous demonstration of the incoherence of endurance, which could be used directly.

V. The Problem of Change

Many perdurantists take themselves to have such an argument. This is the Problem of Change.[6] It is simple to state. Suppose that a certain thing, a poker, say, is hot at one time, t_1, and later, at t_2, cold. And suppose that we have one standard of heat and coldness in mind here, so that it would be contradictory to say of one thing that it is both hot and cold.

The problem is that it's supposed to be the *very same* poker at t_1 and at t_2. No-one has come along and switched pokers on us. But yet this one object is supposed to be both hot and cold. If I told you that I had a poker that was both hot and cold, I would be contradicting myself. We know that there are no such pokers, nor could there be. But if we believe that things can change, then we must believe that one thing can be both hot (at one time) and cold (at another), and we can say so without fear of contradiction.

This intuitive way of stating the argument has some disadvantages. The emphasis on the self-contradictoriness of 'This poker is both hot and cold' suggests that the problem

is a semantic one: 'the problem of specifying the logical form of sentences ascribing temporary intrinsic properties to persisting objects, in such a way that we do not run into contradiction' (Lowe 1988, p. 73). On the contrary, the Problem of Change is supposed to be a serious metaphysical antinomy, which is only to be resolved by adopting a substantive metaphysical doctrine, perdurantism.

To put the problem into sharper focus, let us begin by saying that two things are duplicates if and only if they are intrinsically[7] just alike. Two identical twins are near duplicates, but not quite. Probably the only uncontested instance of genuine duplication that we will ever find is of one thing with itself. For everything is just like itself, nothing can ever be unlike itself.

But it is precisely that one uncontested and uncontestable case that creates problems for us in the case of change. It seems to be essential to intrinsic change, change in temperature for example (or shape, or mass), that the poker of t_2 *not* be a duplicate of the poker of t_1. If the poker of t_2 was a duplicate of the poker of t_1, then one way in which it must duplicate it is the way of temperature. But, by hypothesis, that is not the case. Hence the poker of t_1 is not a duplicate of the poker of t_2. Hence, since everything must be a duplicate of itself, the poker of t_1 is not the same poker as that of t_2.

To summarise:

C1 The poker of t_1 (P-of-t_1) is hot and the poker of t_2 (P-of-t_2) is cold.

C2 *hence,* P-of-t_1 is not a duplicate of P-of-t_2

C3 *hence,* P-of-t_1 is not identical to P-of-t_2

C4 *hence,* The poker has not endured from t_1 to t_2

C5 *hence,* The poker has perdured[8] from t_1 to t_2

For four-dimensionalists, one important solution to the Problem of Change is not available: the adoption of presentism. Presentists believe that '[o]ther times are like false stories', or like ersatz possible worlds (Lewis 1986, p. 204). According to them, there is only one real time, the present, and the only things are those things that occupy that time. Supposing that it is now t_2, and the poker is cold, the presentist will deny that there must be a hot poker to account for the fact that the poker was hot at t_1. All that's required is that there be a a false story, or a merely possible world, according to which t_1 is the present, and the poker is hot. The presentist will thus deny C1.[9]

Setting aside the presentist solution, endurantist solutions to the problem of change have a certain general form. Typically, they offer an analysis of premise C1 that is supposed to show how C2 doesn't follow from C1. It's even possible to understand the perdurantist approach to the problem in this way, that is, as offering an analysis of premise C1:

C1p The temporal part at t_1 of P is hot and the temporal part at t_2 of P is cold.

An endurantist does not have to reject this analysis just because it speaks of temporal parts. Provided that the notion of temporal part is a coherent one, it's trivial that everything has at least one temporal part: itself. But the Problem of Change shows that this endurantist reading of C1p is not tenable: since the temporal parts at t_1 and t_2 are not duplicates, they must be distinct. Hence, the poker must have *more* than one temporal part, and the endurantist cannot accept that.

So it seems that we must search for another analysis. One analysis that endurantists offer, and the one I'll offer, is this one:[10]

C1e P has the property of being hot-at-t_1 and the property of being cold-at-t_2.

In this analysis, we've introduced these properties of being hot or cold at such and such a time, which are called temporally indexed properties. There is no impossibility involved in one thing's having both the property of being hot-at-t_1 and the property of being cold-at-t_2 (whereas there would be in one thing's having both the property of being hot-at-t_1 and the property of being cold-at-t_1). If we can understand premise C1 in the way suggested by C1e, the problem of change is no problem. Merely pointing out that this analysis is available, however, is not enough to solve the problem, for two reasons.

First, the analysis of C1 in terms of C1e is compatible with perdurantism. The believer in temporal parts need not deny the reality of temporally indexed properties: they can be identified with the property of having such-and-such a part. The property of being hot-at-t_1, for example, would be the property of having a hot part located at t_1.

Second, supposing we rule out the perdurantist reading of C1e, we are still left with a mystery. We've said what the temporally indexed properties aren't — what *are* they, then? In order to have a genuine rival account to perdurantism, we need to say more about these properties than that they are not the perdurantist's properties of having such-and-such a part. For perdurantists will presumably believe that there are no other plausible candidates.

It is often assumed that the temporally indexed properties must be relational properties: the property, for example, of bearing the external relation 'hot at' to t_1. But if that's right, then a lot of our commonsense judgements about the intrinsicality of heat, charge, mass, and the like will come out to be wrong. And some of those commonsense judgements may be so entrenched that, were we convinced they were false, we would no longer say that there was such a property, as Lewis suggests is the case with shape: 'if we know what shape is, we know that it is a property, not a relation' (Lewis 1986, p. 204).

VI. Temporally Indexed Properties

If we are to resist the Problem of Change by means of temporally indexed properties, we had better have an account of those properties to act as a genuine rival to perdurantism. And it had better be possible for those properties to be intrinsic. Before I state my account, I will first deal with a problem for any account of temporally indexed properties that takes those properties to be intrinsic (even the perdurantist interpretation of those properties described above). You might think that an indexed property cannot possibly be intrinsic as it makes essential reference to a moment of space-time. Having the property of being hot-at-t_1 entails being located at t_1. But being located at t_1 is extrinsic. Hence, any property the having of which entails that I am located at t_1, cannot be intrinsic.

The answer to this is that we should understand 't_1', as it appears in the names of the temporally indexed properties, as a reference to a moment of time relative to the temporal position of the object that has the property. So we should understand the property of being hot-at-t_1 as, for example, 'the property of being an x such that x is hot for the first second of x's life'. The temporally indexed properties should be understood in a way that makes it possible for objects located at two different times to share such a property. If two pokers, created at different times, were to have the same history of cooling down, and being destroyed, they would share all their temporally indexed heat properties.

This is just a point about how to understand what is required of a temporally indexed property, for it to be worthy of that name, and capable of solving the problem of change. It remains to be shown that there are any such properties (in whatever sense there are properties), and that they are not either the property of having a hot part at t_1, or the extrinsic property of being related in a hot way to t_1. On my account, the temporally indexed properties are perfectly intrinsic and perfectly non-relational. It's just that they are disjunctive.

To explain how this is the case, we need to introduce the notion of a distributional property. The surface of a chessboard has a certain colour distribution. The property of having *that* colour distribution is a distributional property. Or, take a poker that is hot at one end, and cold at the other. It has a certain heat distribution, and has the distributional property of having that heat distribution. Imagine such a poker, call it a, and another poker, b, which has a different heat distribution, being uniformly hot, for example. Call the heat distribution of a, the property A, and that of b, B. Note that these distributional properties are fully determinate: having any one of them entails that you do not have any other of the same determinable (in this case the determinable property of having some heat distribution). So, for example, that a has A entails that a does not have B.

A and B are both intrinsic properties. Though my description of A involved talking about 'ends' of the poker, it's clear that having A involves nothing outside the poker that has the property. Any duplicates of a would have to also have A, or they would not be

duplicates. Now notice that we can define now up the property of being hot at one end. It is simply having *A or B or* any other of the fully determinate heat distribution properties that, as it were, put heat at one end of the object. And this property is intrinsic as well. You can't get an extrinsic property by conjoining or disjoining two intrinsic ones.

A distributional property, then, is a perfectly intelligible kind of property, which everyone ought to believe in to the extent that they believe in any kind of intrinsic property. Disjunctions of them are equally intelligible, and ought to be believed in to the extent that one believes in any disjunctive property.

The disjunctive distributional properties I have just described are spatially indexed properties. For temporally indexed properties, apply this procedure in the temporal case. Imagine now two pokers, one of which begins its life hot, and cools down over time, the other of which remains hot for its entire existence. Call them c and d respectively. Both c and d, we will suppose, begin to exist at t_1, and are destroyed at t_2. If we are to be four-dimensionalists, in the sense of the Dimensionality Thesis, we will think of c and d as four-dimensional objects, extended over time. Just like a and b, c and d have different heat distributions. c is hot at one end, its earlier end, and cold at the other; d, on the other hand, uniformly hot. Just as before, let us give names to their heat distribution properties: c's can be C, and d's D.

Now we can define up the property of being hot at t_1 as the disjunctive property of having either C or D, or any of those other heat distribution properties that, as it were, place heat at the t_1 end of their instance. Just as in the spatial case, this property is perfectly intrinsic and non-relational. Nor, I think, need it commit us to there being any proper parts of an object which has such a property.

To generalise: wherever we have a temporally indexed property of being X-at-t, we have a number of corresponding permanent distributional properties: the X-ness distributions. X-at-t is a disjunction of some of those X-ness distributions, the ones that are compatible with being X-at-t.[11]

VII. Can simple objects have distributional properties?

It might be objected that to have a distributional property, an object must be extended, and nothing can be extended without having proper parts. That just takes us back to the argument from analogy, though. I've already argued that we ought to accept the possibility of extension without parts.

But perhaps a weaker objection can be mounted. It might be thought that objects without proper parts can have distributional properties, but only uniform ones. If that is right, then enduring objects cannot change, as to change (in regard of temperature, for example), on my account, is to have a (in our example, temperature) distribution that is

non-uniform over time.

This proposal is not plausible, however, once the possibility of extended simple objects has been accepted. If an object has extension, then it must be capable of having a shape; and since it would be arbitrary to insist that a simple object must have any particular shape, it must be capable of having any of the shapes that a similar complex object might have. Thus, it must be possible for it to have a non-uniform cross-section over time. For example, an conical object, with the axis of the cone oriented along the time dimension could be small in the spatial dimensions at one time, then larger at a later time. It would be growing, in other words — it would have a non-uniform spatial size distribution, and that is a counterexample to the proposal under consideration.

VIII. What unifies the distributional properties?

One might still be a little suspicious about the theory just advanced. One common suspicion runs like this: What is it that unifies the disjuncts of an indexed property? The only way I've been able to tell you what the disjuncts of, for example, being hot at t_1, are, is by using phrases like 'those heat distributions which place heat, *as it were*, at the t_1 end of their instances'. But this seems a little circular. Which exactly are those heat distributions? And is there a way of answering this question without speaking of 'ends', which in this context must surely be parts?

I don't see any reason to suppose so. But that shouldn't be a problem. Or if it is, it's only a problem in explaining the theory, rather than a problem in the theory itself. There are certainly those distributional properties, in whatever sense there are properties at all; and there are certainly all sorts of arbitrary classes of those properties, in whatever sense there are classes. Among those classes is the one I'm calling 'the class of all those distributional properties that place heat *as it were* at the t_1 end of their instances', and no point about the language I'm using to describe the class can show that if any object has one of the members of that class, then it must have some proper part.

By way of analogy, imagine the class of heights that have been the exact height of Socrates at midnight on some night. There is probably no other way of describing that class except in the way I just did, but it would be a mistake to think that those heights could only be had by anything that shared a universe with Socrates, or that Socrates must exist in order for that class to exist. There is even the disjunctive property of having one of those heights, (in whatever sense there are disjunctive properties), and again, it is a property that could be had without there being Socrates. The problem here is just that finite creatures such as ourselves don't have the language to name and list all the disjuncts.

Nobody would make this mistake about the class of midnight heights of Socrates — why then does it seem tempting in the case of indexed properties? Perhaps what is really

at the back of the mind of someone who objects that they cannot see what unifies the classes of distributional properties is a deeper metaphysical objection about resemblance: Let us return to my example of the two pokers, c, which is hot at t_1, and cold at t_2, and d, which is uniformly hot. These pokers are alike in a restricted way, namely in that they are both hot at t_1. On my account, the pokers share an indexed property.

These indexed properties are supposed to be disjunctive. But there is an influential tradition (Armstrong 1978b; Lewis 1983) claiming that two objects can only resemble each other in virtue of their both possessing some non-disjunctive property. This might seem plausible: a raven and a writing-desk do not resemble each other merely in virtue of their sharing in the property of being either a raven or a writing-desk. There may be some cases where two objects *seem* to resemble each other in this way. For example, two birds might resemble each other in virtue of being either a raven or a crow. But in every such case, so runs the standard story, we will find that the resemblance is subserved by some resemblance in a non-disjunctive respect, in this case, in both birds being corvids, corvidity being a non-disjunctive property.

Of course, this will not be the case for c and d, if c and d have no parts. c and d have entirely distinct distributional properties, C and D, recall. And they need have nothing else in common, save for the disjunctive distributional property of having either C or D. But that's precisely what the traditional account of resemblance rules out. We cannot believe that c and d resemble each other in virtue of being hot at one end, if we think that an indexed property is simply a disjunctive distributional property, not subserved by any non-disjunctive property of parts of the objects in question.

This is a way of making precise the worry about what unifies the disjunctive properties. If you believe the key premise, that resemblance is to be explained by shared non-disjunctive properties, you will be worried by the possibility that things might resemble each other by sharing a temporally indexed property, and that, in that case, temporally indexed properties cannot be analysed disjunctively, as I have done.

One answer to this objection is just to deny the premise, the traditional theory of resemblance. We could replace it, for example, with a natural class theory, according to which things resemble each other in virtue of being in a natural class together. Since classes are extensional, there's no distinction between a disjunctive and and non-disjunctive class. If indexed properties are natural classes, that will explain the resemblance.

We don't need to do this, though. The problem I face here is one that will recur for someone who holds the traditional theory anyway. It is the problem of fundamental determinates. I'm going to use an example from subatomic physics, because that's where we'll find uncontroversial examples of fundamental properties and objects. There are seven charges that a fundamental particle can have: 1, 2/3, 1/3, 0, -1/3, -2/3, and -1.[12]. Take an electron (with charge -1) and a down-quark (with charge -1/3). Electrons resemble

down-quarks in charge (both their charges are negative) — but not in virtue of having a charge in common — the fundamental charges of -1 and -1/3 are quite as distinct as the fundamental charges of -1 and 1. Rather, they resemble in virtue of having similar charges.

This case is quite analogous to the case of the two pokers. c and d resemble not in virtue of having a temporally indexed property in common, but in virtue of having similar distributional properties. D is more like C than like, say, the property of being uniformly cold. Hence d will resemble (as regards temperature) c more than it resembles any poker that remains cold throughout its life. Just as any given electron will resemble (as regards charge) any given down-quark more than it resembles (as regards charge) any given positron.

This is an independent problem that also stands in need of a solution. Whatever that solution is, it can be applied to temporally indexed properties as well.

IX. Conclusion

A four-dimensionalist can accept the account of endurance described above. This fact will be of interest to three groups of people. First, there are the endurantists who may wish to take up four-dimensionalism, the four-dimensionalists who may wish to take up endurantism, and uncommitted folk who may wish to take up both. I heartily recommend the doctrines I have described to such people. They will, however, to judge by the current literature, be in the minority.

Second, there are the perdurantists who, hitherto, have been in the uncomfortable position of having to defend their view as not only true, but a truism. Lewis, for example, says:

> I too would welcome a fourth solution, but for quite a different reason. If [perdurantism] alone is tenable, then our commensense belief in persisting things commits us implicitly to perdurance — and this despite the fact that some of us firmly reject the notion of temporal parts... and many more have never heard of it! (Lewis 1988, p. 76)

Such perdurantists will be only too happy to have a rival account of persistence made available; though they may have to find new and more substantive arguments to show that it is false without showing that it is incoherent.

Third, there are those endurantists who argue against four-dimensionalism by arguing against perdurantism. Judith Jarvis Thomson, for example, argues against the Analogy Thesis, on the grounds that it entails perdurantism, which she dismisses as a 'crazy metaphysic'(Thomson 1983, p. 213). This line of argument clearly cannot work if the entailment is false, as I have shown.

A consistent four-dimensionalist should, inspired by the Analogy Thesis, take the same attitude to temporal parts as to spatial parts. Since, as I have argued, it is an empirical matter whether any given object has spatial parts, we should likewise think it an empirical matter whether any given object has temporal parts. It is a difficult question how we might find out which things perdure and which endure; but that is a different issue from whether either is possible.

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Notes

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[1]This point is not unknown to those writers who use the terms in this way. Theodore Sider, for example, after announcing that he will use 'four-dimensionalism' and 'three-dimensionalism' to mean the same as 'the theory that things perdure' and 'the doctrine that things endure' respectively, says 'We need to look carefully into just what three- and four-dimensionalism amount to. These names for the doctrines... are poor guides' (Sider 1997, pp. 197–198). Peter van Inwagen, who uses a Flatland scenario much like the one I describe, uses scare quotes around 'three-dimensionalism' and 'four-dimensionalism' to highlight their strangeness in that context (van Inwagen 1990a). Trenton Merricks says that he uses the terms 'four-dimensionalism' and 'perdurantism' interchangeably while noting that he does *not* take them to mean the same, for similar reasons (Merricks 1995, p. 525n).

[2]J.J.C. Smart is one of the great masters of this technique: '[I]f time flows, how fast does it flow? Does it flow at one second per second? ... Does my ruler advance at one centimeter per centimeter?' (Smart 1989, p. 34) And on temporal parts: '[Endurantists] may object that according to [perdurantism] we would never see (say) a tomato, because the tomato, as four-dimensional entity would extend into past and future.... in consistency, [endurantists] should say that you never see tomatoes but only their facing surfaces' (Smart 1989, p. 19–20). Richard Taylor lists a number of analogies between space and time in his (1964), among them an analogy between extension in space and persistence through time. This analogy is clearly important for our purposes. It is made the sole content of four-dimensionalism by Mark Heller, whose 'minimal four-dimensionalism' is the thesis 'that persisting objects extend over time in the same way they extend over space' (Heller 1993, p. 49). It is hard to know what this would mean outside of the context of the Dimensionality Thesis. If time were not a dimension, it is hard to see how objects could 'extend' over it in the same way they extend through the spatial dimensions - so I take it that Heller implicitly endorses the Dimensionality Thesis too.

[3]I have earlier cited Peter van Inwagen as someone who uses 'four-dimensionalism' to mean perdurantism. Interestingly, however, if the distinction between entension and pertension is allowed, his definition of 'four-dimensionalism' becomes equivocal. According to him, four-dimensionalism is the view that 'persisting objects are extended not only in the three spatial dimensions, but also in a fourth, temporal dimension, and persist simply by being temporally extended' (van Inwagen 1990a, p. 245). If his 'extended' is taken to mean my 'pertended', then his 'four-dimensionalism' is the Dimensionality Thesis plus perdurantism, which makes it a trivial truth in his usage that a four-dimensionalist must be a perdurantist. On the other hand, if his 'extended' is taken to mean my 'extended', his 'four-dimensionalism' is the Dimensionality Thesis, plus a certain restricted analogy between time and space, specifically between persistence and extension. On this latter reading it is no trivial matter that a four-dimensionalist must believe in temporal parts.

[4]I make some minor use of mereological concepts such as summation in the remainder of this section. The concepts I have in mind are those of the 'classical' mereology, also known as the 'Calculus of Individuals' (Goodman 1951, pp. 42–51). This is also the mereology standardly used by perdurantists such as Lewis (1986, p. 69n). For a comprehensive survey of mereology, including non-classical theories, see Simons (1987).

[5]For a readable introduction to the physics of quarks and leptons, see Fritzsch (1984). On the radius

of electrons, and the practical difficulties of measuring it, see Ridley (1995, pp. 133–138).

[6]For an influential statement of the problem, see Lewis (1986, pp. 202–205) and responses to it, some of which can be found in Lowe (1988, 1987); Lewis (1988); Mellor (1998); Haslanger (1989).

[7]I won't attempt to exactly explicate the idea of intrinsicality here. For an attempt at definition in modal terms, though, see Langton and Lewis (1998).

[8]The move from C4 to C5 deserves more attention than I can give it here. I assume that endurantism and perdurantism are the only available accounts of persistence. There are other possibilities, among them the simple denial that anything persists.

[9]Carter and Hestevold (1997) offer an interesting variant: they claim to deduce perdurantism from 'Static Time', the view that 'objects and events undergo no temporal becoming'. They argue that Static Time entails a thesis they call 'Temporal Parity', which functions to rule out presentist solutions in the same way that four-dimensionalism does.

[10]The major competing analysis indexes not properties, but the instantiation relation that holds between the properties and their instances. (As in Lowe's 'solution (ii)' (Lowe 1988)). I fear that allowing an instantiation relation to do real explanatory work courts Bradley's famous regress of relations (Bradley 1897, pp. 17–18), as is suggested by Armstrong's arguments against 'relational realism' (Armstrong 1978a, p. 106), those forms of realism that have this feature. This worry aside, the motivation for instantiation indexing is that it avoids any pressure to think of indexed properties as relational or extrinsic — but I will argue that there need be no such pressure in any case.

[11]'What of being hot *simpliciter*?' it may be asked. I have nothing very interesting to say about 'hot *simpliciter*' — it's not clear to me that it means something unambiguous. If it means hot in the way that a three-dimensional temporal part of a poker would be hot, then enduring things don't have such properties; but neither do perduring things. If it means hot, as it were, at some time, then it is just a very disjunctive heat distributional property. If it means hot, as it were, at every time, then it is a less disjunctive one (even the property of being permanently hot must be disjunctive, as there are many different temperature distributions that are non-uniform in different ways across space, even if they are uniform along the time axis).

[12]The unit here is e, the charge on an electron — or on a positron, strictly speaking, as an electron is usually said to have charge -1

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